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## **The use of GPS and SMS data to investigate travel experiences**

### *A Danish case study*

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# The use of GPS and SMS data to investigate travel experiences: A Danish case study

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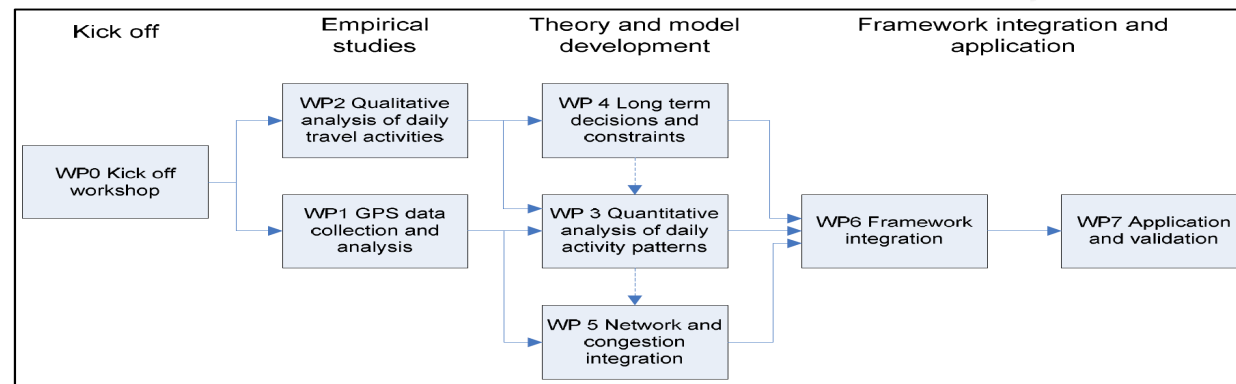
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## The ACTUM research project

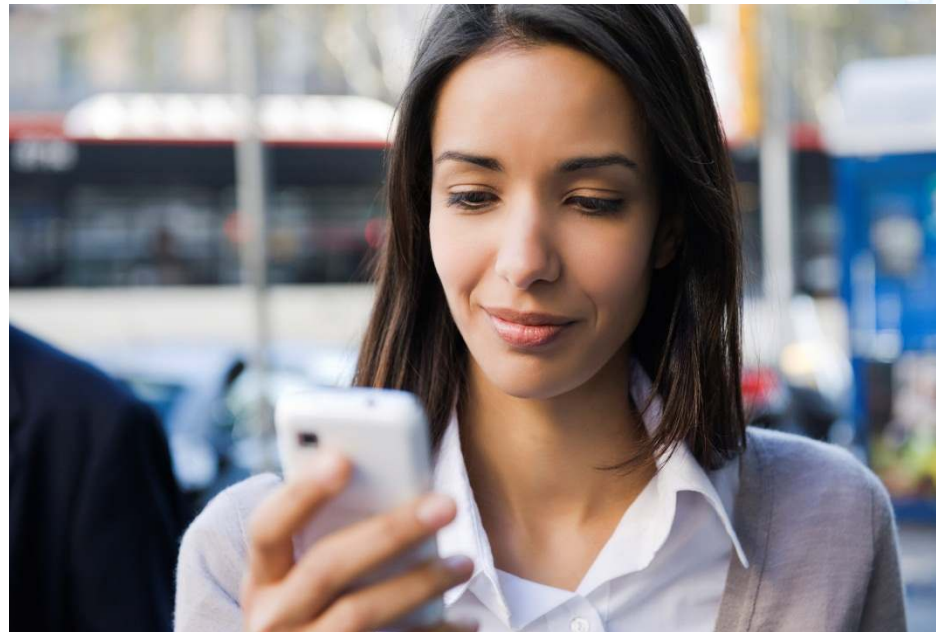
- Funded with 21,6 million Dkr by the Danish Council for Strategic Research.
- “The objective of the project is to provide an activity-based framework that is able to capture and describe individual and household activity patterns within a multi-modal transport environment that is characterized by a diversity of travel mode combinations.”(ACTUM 2010, p.2)
- This GPS tracking project is funded by the ACTUM research project, and the overall objective is to deliver data for the estimation of the activity based models.



(ACTUM 2010, p.5)

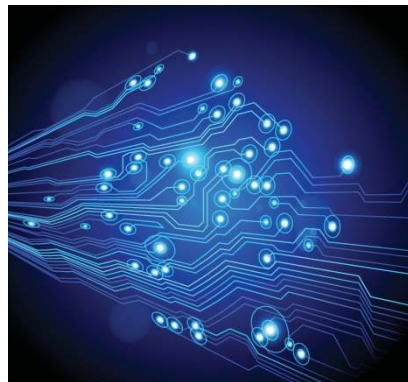
## Research Question

- Can GPS technology and SMS technology be combined into a method which makes it possible to capture trip data which cannot be captured by the conventional combination of GPS tracking and travel diaries?



## The dawn of Activity Based Traffic models

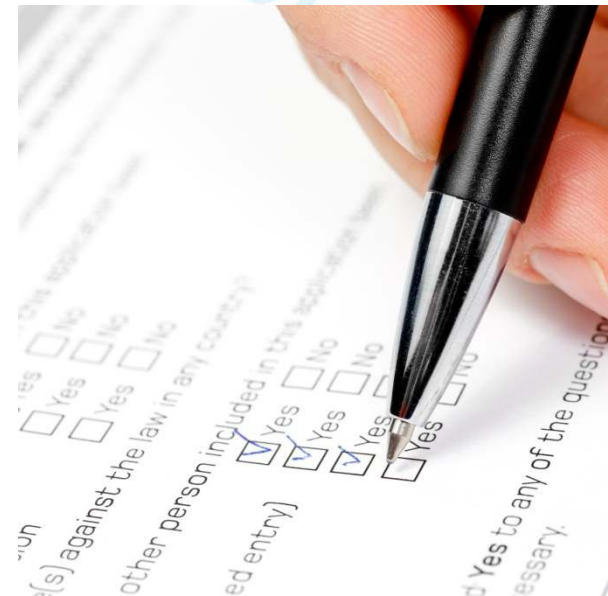
- Need for calibration and validation data is growing



- Trip identification
  - Trip mode
  - Trip purpose
  - (Trip decision-making-processes)\*
  - (Trip experiences)\*
- Mainstream data collection method: Travel diaries

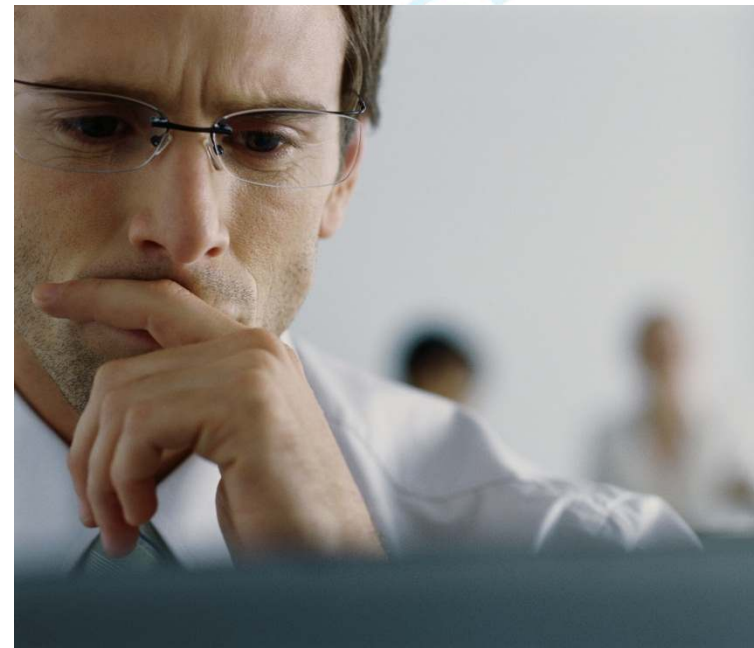
## Combining GPS and travel diaries

- Pure travel diaries
  - Detailed information on each trip and socio-economic background data
  - Missing trips (Forrest and Pearson 2005)
  - Bias toward well off respondents (Forrest and Pearson 2005)
  - Large burden placed on respondents (Ohmori et al. 2005)
  - Expensive method (Ohmori et al. 2005)
- Pure GPS tracking
  - Detailed data on geography of all trips
  - Detailed data on timing of all trips
  - Trips, mode and purpose can partially be calculated from combination of GPS tracks and other GIS data
  - No socio-economic background data
  - No data on home activities
- Prompted recall studies – “The best of both”, but only few studies so far.



## Weaknesses of current combination of GPS and travel Diaries

- Memory bias and post-rationalization!
- Recalling information is as a reconstructive process, influenced by many factors, which limits people ability to give an precise description of past behavior or experience in recall-based self-report procedures (Barrett and Barrett 2001).
- Post-rationalization might also be an issue (Scollon, Kim-Prito, & Diener 2009).



## A solution: Experience Sampling Methods

- “... experience sampling is best thought of as a procedure that allows participants to report the contents of awareness along with the situation in which that awareness takes place” (Barrett & Barrett 2001, p.176)
- Interval-contingent sampling
- Event-contingent sampling
- Signal-contingent sampling





## Our SMS-GPS-Trip-Method

- A contingency based experience sampling setup relying on GPS and SMS technology. The respondents carry a GPS tracker and are asked to send a SMS to a server each time they:
  - Start a trip, containing a description of the purpose of the trip,
  - End a trip, containing a description of mode and a description of the decision-making processes or the experience of the trip.
- “Start SMS” and “Stop SMS” are then paired into pairs constituting a “SMS-trip”.
- Using the timing of the Start and Stop SMSes, GPS points tracked for the respondent in each trip is linked to the SMS-Trips resulting in SMS-GPS-Trips.

## Capturing the experience with the SMS-GPS-Trip-Method

- Our method constitute an event-contingent experience sampling method setup.
- The large literature on the experience sampling method and its advantages documents that such a method is capable of capturing certain types of data, for example data on experiences, which tradition diary studies cannot capture.
- We can therefore conclude theoretically that our method is better suited for collecting certain types of data about trips, than the traditional combination of GPS tracking and travel diaries.

## A casestudy in Copenhagen

- **50 Households (approximately 200 people)**
  - 7 days of GPS tracking
  - Web-survey
  - SMS data about experiences of trips
  - Late September and early October 2011
  - Sample: Mother, father and one or more children over the age of 6.



## An event contingent based study: Setup A (38 households)

- When you start the journey, for example when you exit your front door in the morning, you should send an SMS with the information "Work start" or "School Start" to number 40471443.
- When you arrive at your work/school, you should send an SMS to number 40471443 with the information "Work End" or "School End", as well as what transportation form you used in the journey, for example "Walk Bus" if you walked some of the way and took the bus some of the way.
- In addition we would like if you answer the following question:

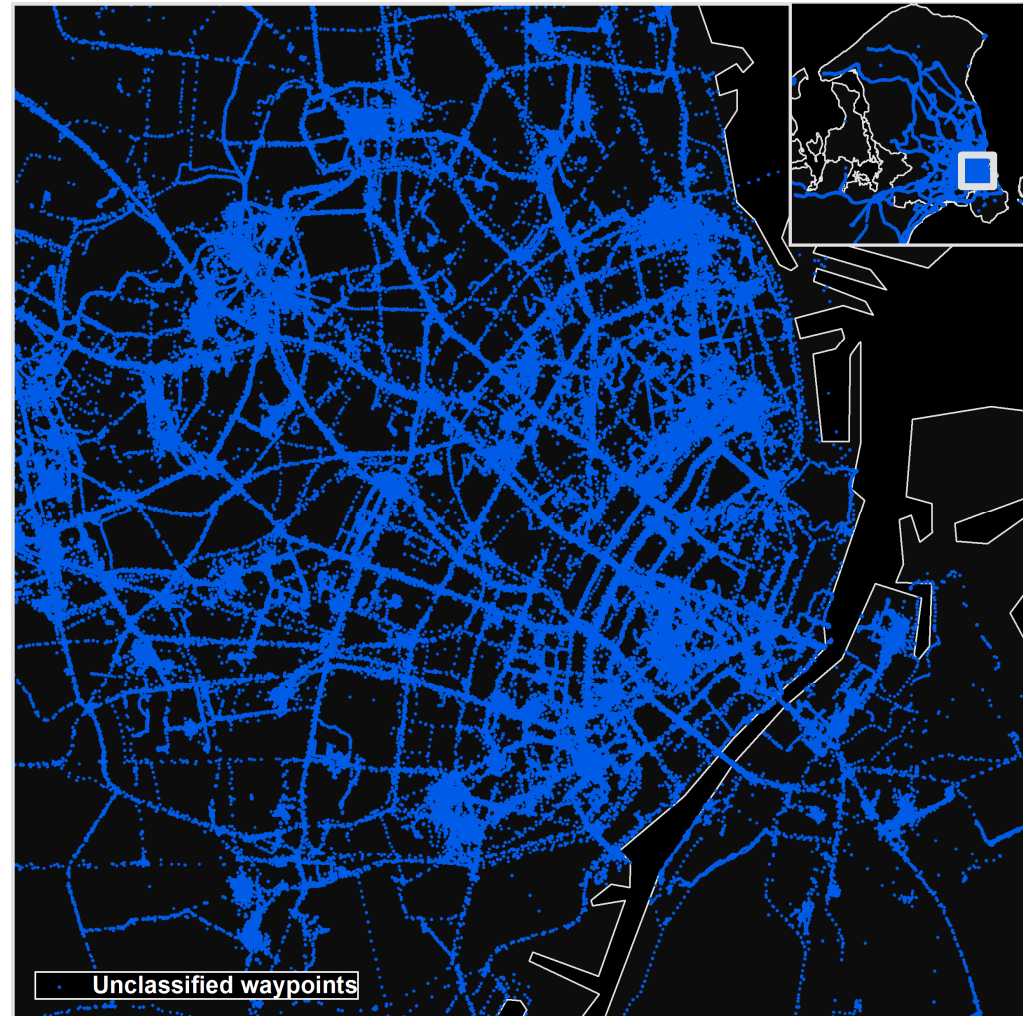
*What three words will you use to describe the experience of the journey you have just been on?*

## An event contingent based study: Setup B (12 households)

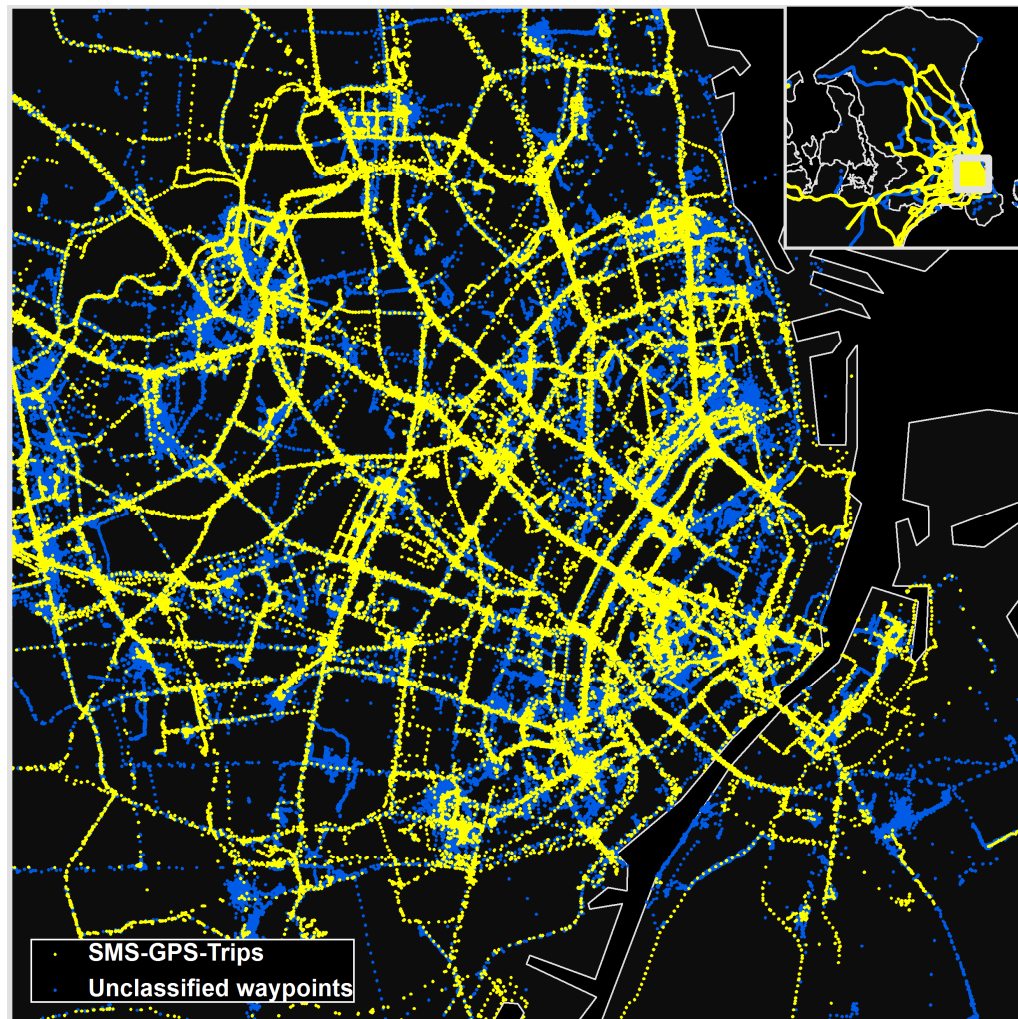
- We would like if you, when you start the journey, will send us one word describing the objective of the journey to number 40471443, for example "Work" if you are heading for work, "School" if you are heading for school, "visit" if you are heading for a family visit, "exercise" if you are heading for exercise, "shopping" if you are going shopping etc.
- When you arrive at your destination, we would like that you send an SMS to number 40471443 with the answer to the following questions:

*What three words will you use to describe the experience of the journey you have just been on?*

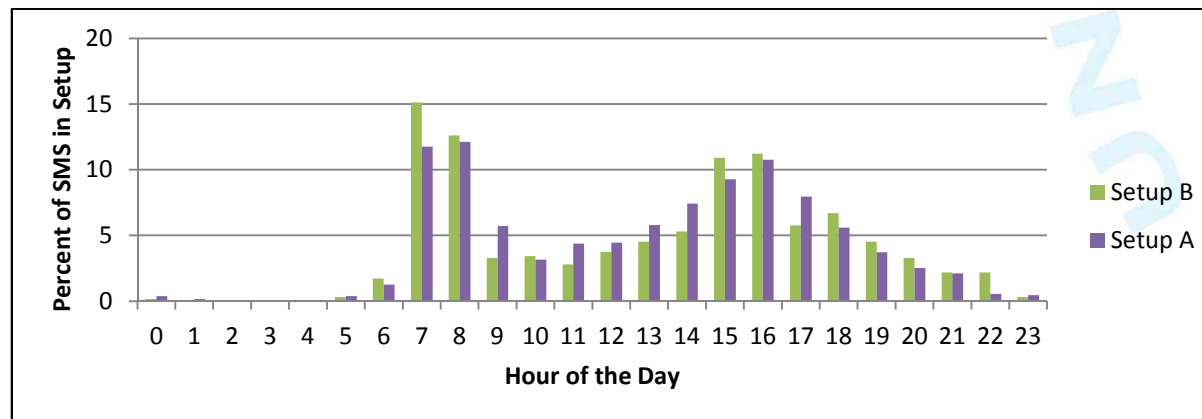
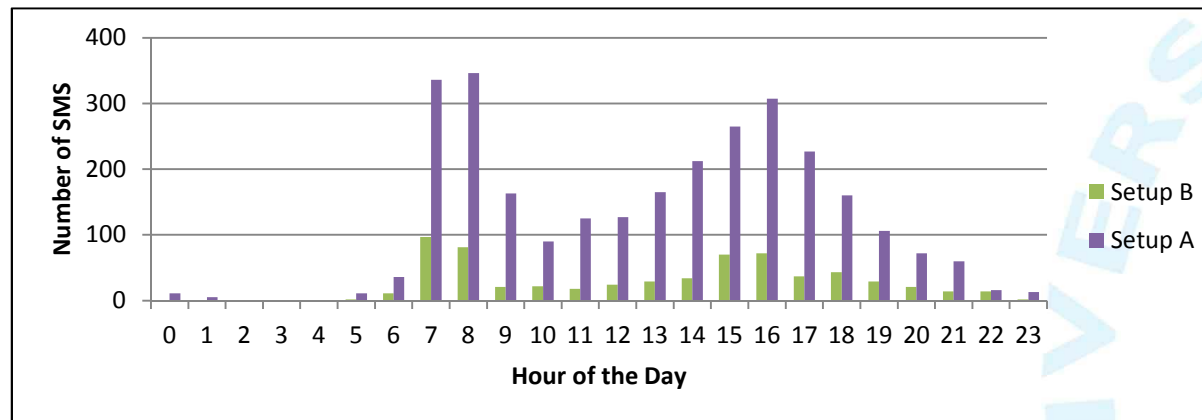
## The GPS data



## The SMS-GPS- Trips



## Timing of 3.497 SMS's received





## The 3.497 SMS's received

All respondents are included in this analysis					
Populations	N pop. 1	Mean pop. 1	N pop. 2	Mean pop. 2	P value two-tail
<i>Comparisons within Setups</i>					
Setup A: Boy - Girl	30	13,67	31	12,52	0,749336856
Setup A: Men - Women	38	23,61	38	30,53	0,068035163
Setup A: Children - Adults	61	13,08	76	27,07	<b>3,17687E-07***</b>
Setup B: Boy - Girl	15	6,60	12	11,17	0,345478121
Setup B: Men - Women	12	14,92	12	19,17	0,301402552
Setup B: Children - Adults	27	8,63	24	17,04	<b>0,006713303***</b>
<i>Comparisons between setups</i>					
Setup A Children - Setup B Children	61	13,08	27	8,63	0,119590168
Setup A Adults - Setup B Adults	76	27,07	24	17,04	<b>0,000556638***</b>
Setup A - Setup B	137	20,84	51	12,59	<b>0,000191436***</b>

(two-sample t-test where we assume unequal variance)

## I.306 SMS-Trips identified

All respondents are included in this analysis					
Populations	N pop. 1	Mean pop. 1	N pop. 2	Mean pop. 2	P value two-tail
<i>Comparisons within Setups</i>					
Setup A: Boy - Girl	30	4,93	31	5,16	0,886990427
Setup A: Dad - Mom	38	9,39	38	12,82	0,069131819
Setup A: Children - Parents	61	5,05	76	11,11	<b>2,42038E-06***</b>
Setup B: Boy - Girl	15	0,67	12	3,83	0,118630981
Setup B: Dad - Mom	12	2,92	12	5,25	0,24051792
Setup B: Children - Parents	27	2,07	24	4,08	0,130176832
<i>Comparisons between setups</i>					
Setup A Children - Setup B Children	61	5,05	27	2,07	<b>0,014276233**</b>
Setup A Parents - Setup B Parents	76	11,11	24	4,08	<b>1,86293E-06***</b>
Setup A - Setup B	137	8,41	51	3,02	<b>6,21103E-08***</b>

(two-sample t-test where we assume unequal variance)

## Capturing mode: Setup A

Mode	Number of SMS-trips	Percentage of SMS-trips with mode
Car	238	25,48
Walk	262	28,05
Train	46	4,93
Bus	25	2,68
Metro	25	2,68
Bike	495	53,00
Taxi	8	0,86
Other (boat etc.)	7	0,75

- 934 of 1152 trips contained mode (81%)
- 136 of the 934 trips contained more than one mode (15%)
- The method is well suited for capturing mode information

## Capturing purpose: Setup A and Setup B

Setup A	SMS-trips	Percentage of trips	Trips pr. respondent	Setup B	SMS-trips	Percentage of trips	Trips pr. respondent
Work	379	32,90	2,77	Work	57	37,01	1,12
School	181	15,71	1,32	School	18	11,69	0,35
Leisure	592	51,39	4,32	Leisure	79	51,30	1,55
Total	1152	100	8,41	Total	154	100	3,02

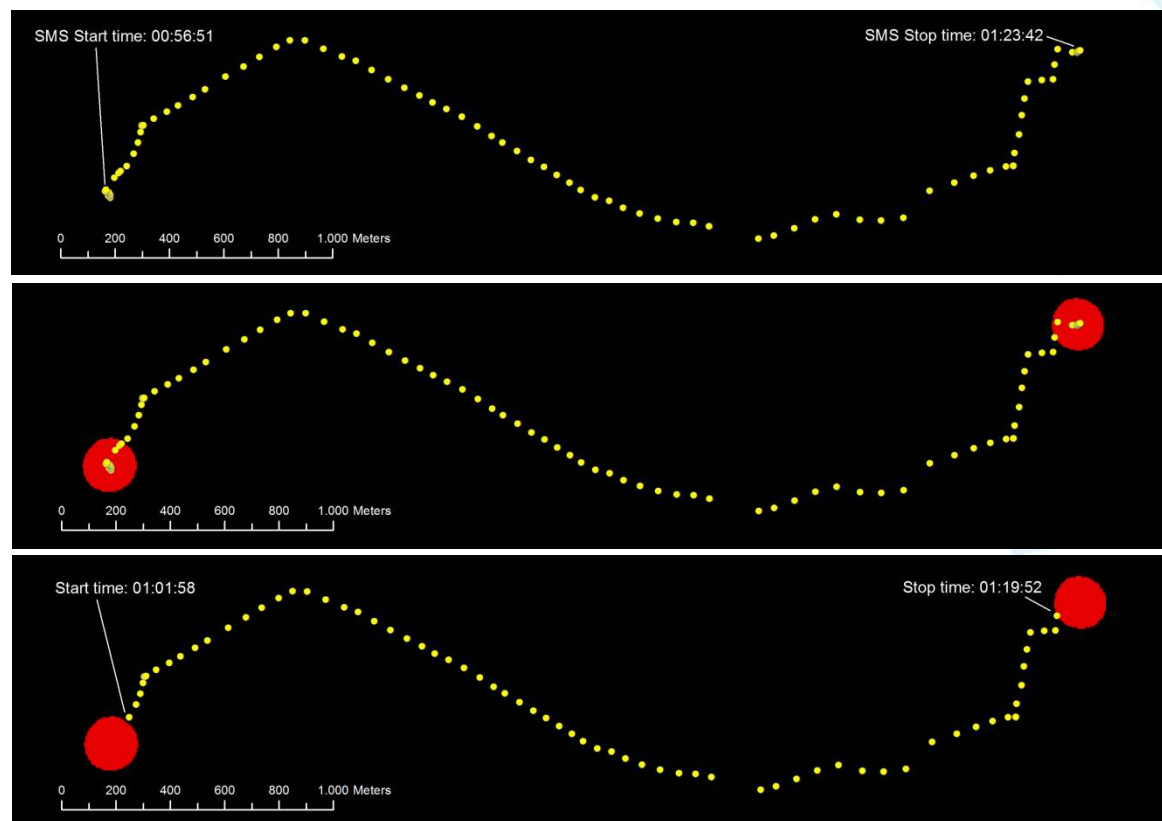
- The method was capable of capturing purpose for all 1306 trips!

## Capturing Experiences: Setup A and Setup B

Setup A				Setup B			
Experiences	SMS-trips	Percentage of trips	Trips pr. respondent		SMS-trips	Percentage of trips	Trips pr. respondent
No Exp.	668	57,99	4,88	No Exp.	20	12,99	0,39
One Exp.	190	16,49	1,39	One Exp.	24	15,58	0,47
Two Exp.	110	9,55	0,80	Two Exp.	37	24,03	0,73
Three or more Exp.	184	15,97	1,34	Three or more Exp.	73	47,40	1,43
Exp. trips total	484	42,01	3,53	Exp. trips total	134	87,01	2,63
SMS trips total	1152	100,00	8,41	SMS trips total	154	100,00	3,02

- A larger question, and thus bigger workload in each SMS-Trip, results in more SMS-Trips with experiences received on average (Setup A vs. Setup B)
- The simpler question in Setup B meant that slightly more trips on average pr. respondent with three experiences were reported in Setup B, but overall Setup A captured more experiences.

## Identifying precise start and stop time of trips



## Conclusions

- We are the first, as far as we know, to suggest theoretically and practically implement the use of SMS technology in such a combination with GPS technology, where the timing of SMS's is used to define trips in the GPS data and the content of the SMS's to capture data about the trips
- The SMS-GPS-Trip-Method is well suited for collecting data on decision-making processes and experiences, which are difficult to capture using diaries and GPS tracking.
- Data collected with our method can be used as a basis for calibration and validation of algorithms for automated trip recognition, trip mode recognition and trip purpose recognition in GPS data, because the method makes it is possible to capture the start and stop times of trips precisely.
- The utilization of SMS technology means that this method can reach a wider group of respondents than is possible with specialized smart-phone apps, which demands that the respondents have smartphones and are willing to, and capable off, installing and using a specialized tracking app.

## Acknowledgements

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**Thank you for your attention!**